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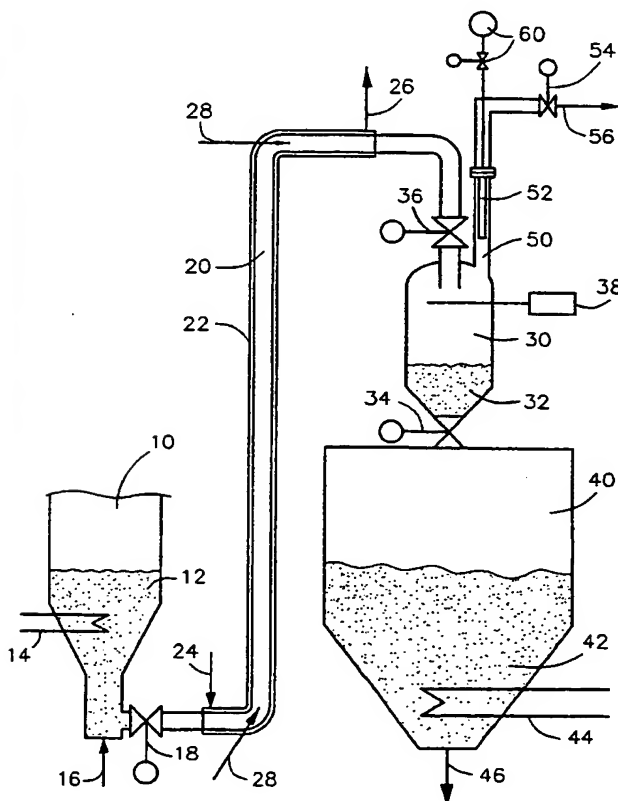
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(54) Title: **METHOD AND APPARATUS FOR TREATING HIGH PRESSURE PARTICULATE MATERIAL**



(57) Abstract: A method and an apparatus for conveying particulate material of a reactor pneumatically from a high pressure delivery vessel (10) to a receiving vessel (40) at a lower pressure using gas discharging from the reactor as a carrier gas, by using an apparatus comprising a conveyor line (20) and a collecting vessel (30), which collecting vessel comprises means (50) to discharge carrier gas and means (54) to control the flow rate of the carrier gas, in which the pressure in the collecting vessel is controlled in such a way that the material has almost the same pressure as the delivery vessel when conveyed to the collecting vessel, from which it is transferred to the receiving vessel essentially at the same pressure as the receiving vessel.

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METHOD AND-APPARATUS--FOR TREATING HIGH PRESSURE PARTICULATE MATERIAL

5 The present invention relates to a method and an apparatus for treating high pressure particulate material as defined in the preambles of the independent claims.

10 Thus the invention relates to a method and apparatus for pneumatic conveying of particulate material containing reaction products of a high pressure reactor, by using the gas exiting the reactor as a carrier gas, from a supply vessel at a pressure of at least 2 bar to a receiving vessel at a considerably lower pressure, by using an apparatus comprising
15 a conveyor line and a collecting vessel between the conveyor line and the receiving vessel.

20 It is generally known to convey solid powdered or granular material by a pneumatic conveyor system. When transported pneumatically, solid material is conveyed in a tubular conveyor line entrained with the carrier gas flowing therein. Pneumatic conveyance is possible for diluted suspensions, whereby a relatively large quantity of gas conveys a relatively small volume of solid material, or for denser
25 suspensions, whereby a relatively small quantity of gas conveys a relatively large volume of solid material.

Pneumatic conveyance is normally performed by feeding superatmospheric carrier gas to a conveyor line or by
30 providing a low pressure in the receiving vessel in the latter end of the conveyor line. Pneumatic conveyance is especially applicable in situations where the supply vessel is for some other reason at a higher pressure than the receiving vessel. Thus it could be possible to utilize the
35 gas in the supply vessel for conveying particulate material

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and it is not necessary to separately arrange carrier gas supply or pressure difference between the vessels.

US patent 4,699,210 discloses a system to convey fly ash from a pressurized fluidized bed boiler separated by its particle separator in such a way that the material to be conveyed is led from the bottom portion of the separator to the ash container through a conduit where its flow direction is sharply changed repeated times. Every change of direction consumes energy, whereby the pressure of the flue gas conveying the ash is reduced gradually on its way from the particle separator to the ash container.

A drawback in this conveyor system is the clogging of the conveyor line's sharp bends, especially if the ash temperature decreases close to the dew point. To prevent the clogging of the line the ash is conveyed as a thin suspension, whereby the flow rate of the gas needs to be high enough, at least 10 - 15 m/s. This results, however, in high consumption of carrier gas and increases thus the energy consumption substantially. In addition, the high flow rate can cause strong erosion especially at the bends of the line where the direction changes.

US patent 4,877,423 discloses a two-stage pneumatic system applicable to conveying and cooling high pressure fly ash, at the first stage of which system, where flue gas is used as a carrier gas, the pressure is reduced only slightly, typically only 0 - 3 bar. In the end section of the first stage is arranged a precipitator to separate flue gas from ash, and a high pressure supply tank for ash. Subsequent to the supply tank the system comprises a lock tank separated by a valve, in which tank the pressure can be reduced to a level required by the further transport and final cooling of the ash.

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flow rate of carrier gas and that the method comprises the steps of:

- (a) controlling the pressure in the collecting vessel by using the means to control the flow rate of carrier gas so that material is conveyed from the supply vessel to the collecting vessel essentially at the same pressure as is prevailing in the supply vessel, and
- (b) conveying material from the collecting vessel to the receiving vessel essentially at the same pressure as is prevailing in the receiving vessel.

In order to solve the above prior art problems an apparatus, the characterizing features of which are disclosed in the characterizing part of the independent apparatus claim, is also provided. Thus the apparatus according to the present invention is characterized in that the receiving vessel comprises a discharge conduit for carrier gas and means to control the discharge velocity of the carrier gas from the collecting vessel, and means to control the pressure of the particulate material collected in the collecting vessel.

The conveyance according to the present invention includes that the flow rate of gas in the conveyor line is preferably relatively low, most preferably less than 5 m/s and particulate material is conveyed as a dense suspension. When the present invention is applied, the frictional forces of the conveyor line are relatively small, whereby the relatively small pressure difference compared to the pressure prevailing in the supply vessel, typically less than 1 bar, between the supply vessel and the collecting vessel, provides a desired flow.

Prior to the conveyance the particulate material may form a thin or a dense layer, e.g. a fluidized bed, in the bottom of

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the supply vessel. The conveyor line may be attached to the supply vessel at the bottom or on the side thereof.

Particulate material can be preferably cooled in the conveyor line by arranging the line at least in some part/-s coaxially so that the particulate material flows in the inner tube and the cooling medium, e.g. water or steam, in the outer tube. A mixer can be also provided between the cooled parts securing that the material is cooled uniformly. The cooling may also be performed or intensified by arranging a heat exchange surface in the supply vessel, collecting vessel or in the receiving vessel.

To prevent clod formation in the conveyed material causing clogging of the conveyor line the material should not be cooled close to the dew point temperature of the carrier gas, i.e., typically, flue gas of a reactor. When utilizing the ash conveyance system according to the present invention, the cooling of the material in the conveyor line can be continued to a lower temperature, if air is added to the carrier gas. Preferably this can be performed by fluidizing the material in the bottom of the supply vessel by air, whereby the flue gas content in the carrier gas is diminished, the partial pressure of water steam and acids is reduced and the dew point of the carrier gas is decreased.

In the method according to the present invention the carrier gas flow from the collecting vessel is adjusted so as to create a desired flow rate for the material between the supply vessel and the collecting vessel. As the discharge conduit for carrier gas is attached to the collecting vessel, the conveyance of the material continues efficiently up to the collecting vessel and the risk that the conveyor line gets clogged up is diminished.

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In the following some preferred embodiments of the present invention are described as applied to the ash conveyance of a pressurized fluidized bed reactor, but equivalent and other
5 embodiments according to the present invention can be used also in connection with other types of reactors and other particulate materials.

If carrier gas is allowed to discharge from the collecting
10 vessel directly to the open air, a substantial amount of particulate material to be conveyed, e.g. ash, may also be discharged. According to a first preferred embodiment of the invention the carrier gas is allowed to discharge from the collecting vessel through one or more porous filter element/-
15 s. The filter elements can be located inside the collecting vessel or in separate gas discharge pipes outside the collecting vessel. From the filter elements the gas is allowed to discharge to the open air or to another vessel which is substantially at the same pressure as the receiving
20 vessel, e.g. at atmospheric pressure. The gas flow is controlled by the control elements located downstream of the filter elements, which control elements can comprise e.g. a control valve or a combination of an orifice plate and a shut-off valve or a combination of a control valve and a
25 shut-off valve.

The ash entrained with the carrier gas to the filter may disturb or even prevent the gas flow. In order to avoid this, the collecting vessel is formed as a settling vessel, whereby
30 it serves as a preseparator for ash. As a certain amount of ash is in any case entrained with the carrier gas, the filter elements can preferably be cleaned from the material collected on their surface by using high pressure gas pulses.

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According to a second preferred embodiment of the invention the carrier gas is allowed to discharge from the collecting vessel through an orifice of proper size directly to the receiving vessel. Thus the ash entrained with the gas is not allowed to reach the environment but is directed to the receiving vessel. The drawback of this embodiment could be the erosion or plugging of the orifice deriving from ash. To eliminate this problem the orifices are preferably made easily changeable.

To control the ash flow rate the gas discharge system comprises preferably two or more parallel gas discharge conduits having an orifice of the same size or of different sizes between the collecting vessel and receiving vessel. The carrier gas discharge conduits are provided with valves, by shutting and opening of which the gas discharge and the ash flow in the conveyor line can be controlled.

As the gas is discharged to the receiving vessel, the receiving vessel needs to be provided with a gas discharge opening, e.g. to the open air, and a filter preventing the ash from exiting through the discharge opening.

The ash conveyor system according to the above preferred first and second embodiments of the present invention is preferably used intermittently, whereby ash is collected in the collecting vessel until its surface reaches a certain predetermined level. After this the ash collected in the collecting vessel is discharged to the receiving vessel.

As the receiving vessel is typically at atmospheric pressure or at least essentially at a lower pressure than the collecting vessel during the conveyance of ash, the pressure of the material to be discharged has to be reduced close to

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the pressure of the receiving vessel before discharging the collecting vessel. To reduce the pressure in the collecting vessel a shut-off valve can be disposed in the ash conveyor line, preferably at its end closest to the collecting vessel making it possible to separate the collecting vessel from the conveyor line.

Preferably the discharge of the collecting vessel is started by closing the valve controlling the gas exhaust from the collecting vessel. Thus the gas pressure in the conveyor line is increased essentially to the same pressure level as the gas in the supply vessel and the ash flow in the conveyor line is stopped. Next, the shut-off valve arranged in the conveyor line is shut and the valve controlling the discharge of the gas in the collecting vessel is reopened, whereby the gas pressure in the collecting vessel is reduced. When the pressure is low enough, the collected ash is removed from the collecting vessel to the receiving vessel.

The collecting vessel can preferably be disposed above the receiving vessel, whereby the ash is allowed to fall directly down to the receiving vessel, after the pressure in the collecting vessel has been allowed to fall to the same level as the pressure in the receiving vessel.

The ash can be conveyed from the collecting vessel to the receiving vessel also by other means, e.g. by using a screw or pneumatically, whereby the pressure in the collecting vessel can remain even slightly higher than the pressure in the receiving vessel, when the pressure is reduced, and the carrier gas can be used for conveying the ash to the receiving vessel.

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The essential idea of the present invention is that the valve disposed in the conveyor line is not used for controlling the ash conveying speed, but only for separating the collecting vessel from the conveyor line after the ash flow has been
5 stopped by the valves controlling the gas discharge.

The valves controlling the gas exhaust can preferably be used not only for stopping the ash conveyance for the discharge of the collecting vessel, but also for controlling the ash
10 conveying speed. It is especially preferable to change the conveying speed intermittently, e.g. so that the conveyance is performed essentially at constant speed, but is stopped completely at regular intervals. Thus excessive rising or falling of temperature as well as the generation of
15 agglomerations disturbing the conveyance can be prevented. If ash is collected only to a minor extent, even carrier gas can be saved by using intermittent ash conveyance thus improving the efficiency of the plant.

Intermittent stopping of the ash conveyance can be controlled on the basis of certain variables measured in the conveyance system. The ash conveyance can be stopped e.g. when the temperature of the ash entering the collecting vessel or the pressure difference between the supply vessel and collecting
20 vessel is too high or too low. Too high a temperature indicates that the volume of ash to be conveyed is so large that the cooling has no time to reduce its temperature sufficiently. Too high a pressure difference indicates that the line might be about to get plugged and the gas discharge
25 from the collecting vessel has to be temporarily shut in
30 order to control the situation.

On the other hand, too low a pressure difference or a temperature of the entering ash can indicate that the ash

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conveyance is insignificant, probably for the reason that there is no ash in the supply vessel. In this case the conveyance should be temporarily stopped in order to save carrier gas and energy. Excessive cooling of the ash also
5 increases the risk of plugging of the conveyor line. The temperature of the ash entering the collecting vessel is preferably less than 300 °C, more preferably 100 - 200 °C. The pressure difference between the supply vessel and the collecting vessel is preferably 0.1 - 1.0 bar or less than
10 0.3 bar for each 10 m of the conveyor line.

The conveyor systems according to the above-described first and second embodiments of the present invention can be used e.g. for conveying fly ash separated by a flue gas filter
15 unit of a pressurized fluidized bed reactor used for combustion or gasification of material.

According to a third preferred embodiment of the present invention the collecting vessel has a tubular form and it is
20 arranged in a vertical position so that ash enters the collecting vessel through its upper part. Typically, the proportion of the height and the diameter of the collecting vessel is at least 5, more preferably at least 10, but it can preferably be even over 30. Thus the first gas discharge pipe
25 provided with a filter is preferably disposed in the lower part of the vessel and the ash discharge system in the bottom of the vessel. There are possibly a plurality of gas discharge pipes at various levels of the vessel. The filter attached to the discharge pipes can preferably be arranged inside the
30 tubular collecting vessel in contact with the material to be conveyed.

When using the ash discharge system according to the third preferred embodiment, the ash disposal from the collecting

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vessel is preferably controlled by an ash column having an approximately constant height in the tubular collecting vessel. As the carrier gas passes through the ash column, its pressure falls without any separate means so that ash can be removed from the lower part of the collecting vessel, directly to an ash container, e.g. at atmospheric pressure. This kind of a conveyance system is particularly suitable for removing coarse bottom ash, e.g. from the furnace of a fluidized bed reactor used for combustion or gasification of material.

The collecting vessel according to the above-described third embodiment can also be dimensioned so that it has a self-adjusting overfill protector. Thus the diameter and the height of the vessel have to be such that the airflow through the ash column slows down essentially before the ash column in the vessel is too high, whereby the ash conveyance to the collecting vessel is reduced or even stopped completely.

In all above-described embodiments the conveyor line comprises parts that can be oriented with any desired position, i.e. vertical, horizontal or oblique. If necessary, the flow of the particulate material in the conveyor line, especially where the line is bent, can be assisted by introducing small quantities of carrier gas, e.g. air, into the line continuously or intermittently.

The invention is characterized in that there are no valves for controlling the conveying speed of the ash in the ash conveyor line. There can be shut-off valves in the line intended to be used when a part of the system needs to be separated from the others, e.g. for maintenance.

In the following the invention will be described more closely with reference to the accompanying drawings, in which

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Fig. 1 schematically illustrates an ash conveying system according to a first preferred embodiment of the present invention;

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Fig. 2 schematically illustrates the outlet end of the ash conveying system according to a second preferred embodiment of the present invention;

10 Fig. 3 schematically illustrates the outlet end of the ash conveying system according to a third preferred embodiment of the present invention;

Fig. 1 illustrates an ash conveying system according to a
15 first preferred embodiment of the present invention, the supply vessel 10, ash conveyor line 20 and receiving vessel 40 of which can be similar to those even in other preferred embodiments. The various embodiments differ from each other mainly in how the carrier gas discharge from the collecting
20 vessel 30 and the pressure reduction of the collected material are arranged.

The invention is characterized in that particulate material containing reaction products of a reactor is conveyed
25 pneumatically from a supply vessel 10 at a pressure of at least 2 bar, typically at 6 - 20 bar, to a receiving vessel 40, e.g. at atmospheric pressure, using the gas exiting the reactor as a carrier gas. When applying the invention the volume of the supply vessel is typically larger than the
30 volume of the conveyor line and it can be assumed that the pressure of the supply vessel is constant.

The supply vessel 10 can consist e.g. of a bottom part of a filter for fly ash from a high pressure fluidized bed reactor

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or it can be a part of the removal system for bottom ash from a fluidized bed reactor. In the former case the ash 12 collected in the supply vessel is powdered, compressible fly ash, whereas in the latter case the ash could be coarse. The quality of the ash to be conveyed has to be considered when choosing the embodiment and the method, by which the system according to the present invention is applied.

In the supply vessel the ash temperature is typically 400 - 1200 °C and for precooling the ash the vessel can be provided with heat exchange surfaces 14, e.g. heat exchange pipes, in which water or steam circulates.

The ash is conveyed in a tubular conveyor line 20, in which a heat exchange surface could be arranged, e.g. a sleeve 22 covering the line at least partly and having means 24, 25 for the recirculation of heat exchange medium, e.g. water or steam. By the heat exchange surfaces 22 the ash temperature can be reduced, e.g. to 150 - 300 °C.

It is possible to arrange means 16 for the introduction of fluidizing gas, e.g. air, at the bottom of the supply vessel. These can prevent the clogging of the lower part of the collecting vessel deriving from the arching of ash. Further, fluidizing air can be mixed in the carrier gas used in the conveyance, and reduce its dew point. Thus the clogging of the conveyor line due to moistening as the result of ash cooling can be prevented.

In Fig. 1 the conveyor line 20 starts below the supply vessel, turns upwards after the horizontal section and leads again horizontally above the collecting vessel 30. In practice, the conveyor line can consist of parts with any desired position. To avoid the clogging of the line it could

be occasionally or continuously necessary to add small quantities of carrier gas 28, e.g. air, to some points of the line, especially to the bent sections.

- 5 The ash conveyor line 20 ends in the collecting vessel 30, to which a discharge conduit 50 for carrier gas is attached. The conveyor line 20 is preferably formed of an extension part 32 extending slightly into the collecting vessel and directing the ash towards the bottom of the collecting vessel 30 thus
10 reducing the probability of the ash being entrained with the gas to the discharge conduit 50. The collecting vessel 30 is also formed so as to reduce the speed of the carrier gas essentially when flowing from the extension part 32 of the conveyor line 20 to the collecting vessel. Thus the
15 collecting vessel serves as a settling chamber for ash separating a substantial part of the ash conveyed by the carrier gas.

- In the embodiment according to Fig. 1 the discharge conduit
20 50 is provided with a filter 52 and a control valve 54 for controlling the flow rate of the discharged carrier gas 56. The discharge conduit leads preferably to the open air or to a space essentially at atmospheric pressure. If the pressure of the receiving vessel differs from the atmospheric
25 pressure, it is preferable to draw the discharge conduit 50 to a space essentially at the same pressure as the receiving vessel.

- As ash can be entrained with the carrier gas to the filter
30 52, the filter is provided with means 60 for cleaning the filter by giving intermittent gas pulses to the clean side thereof.

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In the embodiment according to Fig. 1 the collecting vessel 30 is arranged immediately above the receiving vessel 40. The collecting vessel 30 is separated from the receiving vessel 40 by a gas tight valve 34. There is also a gas tight valve 36 between the collecting vessel 30 and the conveyor line 20.

The present invention is characterized in that the gas discharge speed is adjusted by a control valve 54 so as to convey ash in the line 20 as a dense suspension the flow rate of the carrier gas being less than 5 m/s. Thus the erosion and consumption of carrier gas caused by the conveyance are relatively insignificant. Valve 34 is shut and valve 36 is open during the conveyance. It is to be noted that valve 36 is not used for controlling the conveying speed of the ash or for stopping thereof.

In the technical solution according to Fig. 1 a valve 18 is also arranged between the supply vessel 10 and the conveyor line 20. The system may include such a valve and possibly even other valves not marked in the figure, as they do not have any significance from the viewpoint of the present invention. Valve 18 could be needed e.g. when maintaining the system, but in normal operation the valve is open.

When the level transmitter 38 attached to the collecting vessel 30 indicates that the collecting vessel is about to get filled, the ash conveyance is stopped. The carrier gas flow is stopped by shutting valve 54. When the ash conveyance is stopped, valve 36 is shut. After this, valve 54 is reopened and the pressure of the collecting vessel is allowed to fall so that it is essentially the same as the pressure of the receiving vessel and the ash can fall down into the receiving vessel by opening the valve 34.

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To restart the ash conveyance, valve 34 is shut, valve 36 is opened and the ash flow rate is adjusted by valve 54 to a desired value. To protect valve 36, it could be necessary to raise the pressure of the collecting vessel essentially to the same level as that of the supply vessel 10. This can preferably be performed by using a system 60 producing cleaning pulses for the filter 52 of the discharge conduit 50. Simultaneously, the filter is also cleaned from ash possibly collected on its surface at the preceding filling stage of the collecting vessel. The receiving vessel can be provided with heat exchange surfaces 44 for the final cooling of the ash as well as with an opening for ash discharge 46 in the bottom of the vessel.

The ash conveyance system according to the present invention is preferably used intermittently also between the discharges of the collecting vessel 30 so that the temperature T_1 of the ash entering the collecting vessel 30 at the end of the conveyor line 20 and the pressure difference Δp between the supply vessel and the collecting vessel are monitored. When T_1 or Δp is not within the predetermined limits, the discharge of carrier gas and the ash conveyance are stopped by valve 54. Sometimes it could be sufficient to perform the ash conveyance in a predetermined way intermittently. The ash conveyance can also be stopped when it is detected that the volume of ash in the supply vessel falls below a predetermined level.

Fig. 2 schematically illustrates the outlet end of the ash conveying system according to a second preferred embodiment of the present invention. There the collecting vessel 130, receiving vessel 140, valves 136 and 134 and the parts missing in the figure are similar to those in the embodiment

according to Fig. 1. The operational principle of this embodiment is also similar to that of the embodiment according to Fig. 1.

5 The second preferred embodiment according to Fig. 2 differs from the first preferred embodiment according to Fig. 1 in that the discharge conduit for carrier gas is in communication with the receiving vessel 140. Thus also the ash entrained with the carrier gas is led to the receiving
10 vessel 140. Naturally, when using the second preferred embodiment according to Fig. 2, the receiving vessel has to be provided with a discharge conduit 162 for gas, e.g. to the open air, and a filter 162 preventing the ash from being entrained out with the gas.

15 In the embodiment according to Fig. 2 the discharge conduit is divided into three parallel conduits 150, 150' and 150'' joining to one conduit 160 before reaching the receiving vessel 140. As the ash entrained with the carrier gas could
20 deteriorate the operational condition of the control valve, the control valve 54 of Fig. 1 has been replaced by steadier shut-off valves 154, 154', 154'' and critical openings 158, 158', 158'', like or unlike each other, restricting the gas flow. Naturally the number of parallel conduits can also be
25 different from three.

In the embodiment according to Fig. 2 the ash conveying speed can be controlled by opening a necessary number of the shut-off valves 154, 154', 154''. If ash is conveyed periodically,
30 the extent of the conveyance can also be regulated by changing the duration of the periods, whereby it is not necessary to have more than one discharge conduit, shut-off valve and critical opening.

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Fig. 3 schematically illustrates the outlet end of the ash conveying system according to a third preferred embodiment of the present invention. In this embodiment the collecting vessel 230 at the end of the conveyor line is narrow and high, even though its diameter is larger than that of the conveyor line. The proportion of the height of the collecting vessel to its diameter is preferably at least 5, most preferably at least 10.

10 When conveying ash, an ash column is maintained in the collecting vessel extending preferably at least to the center part of the vessel. In the embodiment according to the figure the ash flow is regulated by a discharge conduit 250 for carrier gas attached to the center part of the collecting
15 vessel, in which conduit the volume of carrier gas 256 can be regulated by a valve 254. At the end of the discharge conduit closest to the collecting vessel is arranged a filter 252 preventing the ash from entering the discharge conduit 250. When the filter is disposed according to the figure inside
20 the ash column flowing downwards, the moving ash simultaneously cleans the outer surface of the filter and prevents the filter from being clogged up.

Another advantage gained by arranging the first end of the
25 discharge conduit in the area of the ash column is that the portion of the ash column above the joining point of the discharge conduit also acts as a restrictor for the carrier gas flow. Thus the ash conveyance is partly self-adjusting as the high ash column slows down the gas flow and reduces or
30 even stops the ash conveyance, when the collecting vessel is about to get filled.

The discharge conduit 250 can also be arranged in the upper part of the collecting vessel, whereby it functions in the

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same way as the discharge conduit according to the first preferred embodiment in Fig. 1. It is also possible to connect the discharge conduit 250 to the lower part of the collecting vessel 230, whereby the flow regulating effect of the ash column is at its highest.

Fig. 3 also shows another discharge conduit 260 for gas provided with a filter 262 and a control valve 264. The purpose of the discharge conduit 260 is to let the carrier gas 266 discharged from the lower part of the collecting vessel enter the open air without any particular obstruction, i.e. during the ash conveyance valve 264 does not essentially limit the gas flow. Thus the lower part of the collecting vessel 230 reaches the atmospheric pressure and the ash 272 can be easily removed from the lower part of the collecting vessel to the receiving vessel, e.g. by using a lockhopper 270. The discharge apparatus for ash at the bottom of the collecting vessel can also be another, e.g. a conveyor screw or an L-valve. Pressure adjusting in the collecting vessel can also be practiced in many steps, whereby more than the mentioned two discharge conduits for gas are disposed in the collecting vessel.

Fig. 3 also shows a level transmitter 238 provided in the upper part of the collecting vessel, and an apparatus 258 for feeding high pressure cleaning pulses to the filters 252 and 262. The collecting vessel can also be used so that the upper surface of the ash column is continuously maintained on a desired predetermined level by using a lockhopper 270. Another possibility is to use a lockhopper intermittently, whereby the ash level remains within certain predetermined limits.

When starting the ash treatment system according to Fig. 3, e.g. sand can be fed to the collecting vessel through a separate conduit not shown in Fig. 3, whereby a sand column restricts the gas flow at the starting stage.

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The invention has just been described in connection with embodiments that are presently considered as the most preferable, but it must, however, be understood that the invention is not limited to these embodiments only, but it also covers a number of other arrangements within the scope of invention determined by the patent claims below. E.g. a plurality of ash conveyor lines can lead into the same collecting vessel.

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4. Method of conveying particulate material according to claim
3, characterized in that the particulate material in the
supply vessel is fluidized by air that is mixed in the carrier
5 gas decreasing the dew point thereof.

5. Method of conveying particulate material according to claim
1, characterized in that a filter is arranged in the discharge
conduit for carrier gas, the means to control the flow rate of
10 the gas includes a control valve downstream from the filter,
and in step (a) the carrier gas is discharged from the
collecting vessel to a space at the pressure which is
essentially the same as is prevailing in the receiving vessel.

15 6. Method of conveying particulate material according to claim
1, characterized in that the carrier gas is discharged from
the collecting vessel to the receiving vessel in step (a).

7. Method of conveying particulate material according to claim
20 6, characterized in that more than one parallel lines for the
discharge of carrier gas are provided between the collecting
vessel and the receiving vessel, which lines are provided with
a constantly open flow restricting element and a shut-off
valve, and the control of the discharge velocity is performed
25 by opening and shutting the shut-off valves.

8. Method of conveying particulate material according to claim
7, characterized in that the flow restricting elements are
easily changeable.

30 9. Method of conveying particulate material according to claim
5, characterized in that the collecting vessel has an
elongated form and it is arranged in a vertical position, and
a column of particulate material is maintained in the

collecting vessel, and the discharge conduit for carrier gas is attached to the collecting vessel at the bottom section of the particulate material column.

- 5 10. Method of conveying particulate material according to claim 9, characterized in that more than one discharge conduit for carrier gas are provided and these are attached to the collecting vessel at various levels of the particulate material column.

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11. Method of conveying particulate material according to claim 9, characterized in that the pressure in the bottom section of the particulate material column is approximately the same as is prevailing in the receiving vessel and step (b)
15 is practiced intermittently or continuously from the bottom section of the collecting vessel.

12. Method of conveying particulate material according to claim 1, characterized in that a gas tight inlet valve is
20 disposed in the conveyor line before the collecting vessel and a gas tight discharge valve is disposed between the collecting vessel and the receiving vessel, and steps (a) and (b) are practiced in alteration step (b) comprising the sub-steps of:
(b1) stopping the discharge of carrier gas from the collecting
25 vessel by using the means to control the carrier gas flow, whereby the conveyance of particulate material is stopped;
(b2) closing the shut-off valve before the collecting vessel;
(b3) allowing the discharge of carrier gas from the collecting vessel until the pressure in the collecting vessel has dropped
30 approximately to the same level as the pressure of the receiving vessel;
(b4) opening the discharge valve and conveying the particulate material from the collecting vessel to the receiving vessel;
and

(b5) closing the discharge valve, opening the inlet valve and returning to step (a).

13. Method of conveying particulate material according to claim 1, characterized in that the collecting vessel is disposed above the receiving vessel and in step (b) the particulate material is allowed to fall down to the receiving vessel.

14. Method of conveying particulate material according to claim 1, characterized in that in step (a) the flow rate of the carrier gas is periodically changed by stopping the conveyance for a predetermined time at regular intervals or when the pressure in the collecting vessel or the temperature of the material entering the collecting vessel is not within predetermined limits.

15. Apparatus for pneumatic conveying of particulate material containing reaction products of a high pressure reactor from a supply vessel at a pressure of at least 2 bar to a receiving vessel at a considerably lower pressure, said apparatus comprising a conveyor line attached to the supply vessel and a collecting vessel between the conveyor line and the receiving vessel, characterized in that the collecting vessel comprises a discharge conduit for carrier gas, means to control the discharge velocity of the carrier gas from the collecting vessel, and means to control the pressure of the material collected in the collecting vessel.

16. Apparatus for conveying particulate material according to claim 15, characterized in that heat exchange surfaces are disposed in the conveyor line.

17. Apparatus for conveying particulate material according to claim 16, characterized in that elements for fluidizing the particulate material are disposed in the supply vessel in such a way that air used for the fluidization is mixed in the carrier gas thus decreasing the dew point of the carrier gas.

18. Apparatus for conveying particulate material according to claim 15, characterized in that a filter is disposed in the discharge conduit for carrier gas, the means to control the flow rate of the carrier gas including a control valve is arranged downstream from the filter, and the discharge conduit for carrier gas is in flow communication with the open air.

19. Apparatus for conveying particulate material according to claim 15, characterized in that the discharge conduit for carrier gas is in flow communication with the receiving vessel.

20. Apparatus for conveying particulate material according to claim 19, characterized in that more than one parallel lines for the discharge of carrier gas are provided between the collecting vessel and the receiving vessel, which lines are provided with a constantly open flow restricting element and a shut-off valve.

21. Apparatus for conveying particulate material according to claim 20, characterized in that the flow restricting elements are easily changeable.

22. Apparatus for conveying particulate material according to claim 15, characterized in that the collecting vessel has an elongated form and it is disposed in a vertical position, and the discharge conduit for carrier gas is attached to bottom section of the collecting vessel.

23. Apparatus for conveying particulate material according to claim 22, characterized in that more than one discharge conduit for carrier gas are provided and these are attached to
5 the collecting vessel at various levels.

24. Apparatus for conveying particulate material according to claim 15, characterized in that a gas tight valve is disposed in the conveyor line before the collecting vessel and between
10 the collecting vessel and the receiving vessel.

25. Apparatus for conveying particulate material according to claim 15, characterized in that the collecting vessel is disposed above the receiving vessel and a valve is arranged
15 between the vessels, through which valve the particulate material may fall down to the receiving vessel.



patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European
patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE,
IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG,
CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

*For two-letter codes and other abbreviations, refer to the "Guid-
ance Notes on Codes and Abbreviations" appearing at the begin-
ning of each regular issue of the PCT Gazette.*

Published:

— *With international search report.*

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 00/00546

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B01J 3/02, F23C 10/16, F23C 10/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B01J, B65G, F23C, F23J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0582049 A1 (DEUTSCHE BABCOCK ENERGIE- UND UMWELTECHNIK AKTIENGESELLSCHAFT), 9 February 1994 (09.02.94), column 4, line 54 - column 5, line 2, figure 1 --	1,5,14,15,18
X	US 4983188 A (HORST MIELKE ET AL), 8 January 1991 (08.01.91), column 2, line 4 - line 29, figure 1 --	1,12-15,18, 22,24,25
X	US 5707198 A (TYGE VIND), 13 January 1998 (13.01.98), column 1, line 57 - column 2, line 8; column 3, line 66 - column 4, line 16, figure 1, abstract --	1,13,15,25



Further documents are listed in the continuation of Box C.



See patent family annex.

*

Special categories of cited documents:

"A"

document defining the general state of the art which is not considered to be of particular relevance

"E"

earlier document but published on or after the international filing date

"I"

document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O"

document referring to an oral disclosure, use, exhibition or other means

"P"

document published prior to the international filing date but later than the priority date claimed

"I"

later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X"

document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y"

document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&"

document member of the same patent family

Date of the actual completion of the international search

11 October 2000

Date of mailing of the international search report

18 -10- 2000

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 00/00546

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Patent Abstracts of Japan, abstract of JP 7-42910 A (MITSUBISHI HEAVY IND LTD), 10 February 1995 (10.02.95)	15,16,24,25
A	--	1-3,13
X	US 4877423 A (FRANK DZIOBEK ET AL), 31 October 1989 (31.10.89), column 1, line 62 - column 2, line 17, figure 1	15,16,25
A	-- -----	1-3,13

INTERNATIONAL SEARCH REPORT

Information on patent family members

01/08/00

International application No.

PCT/FI 00/00546

Patent document cited in search report			Publication date	Patent family member(s)			Publication date
EP	0582049	A1	09/02/94	DE	4225482	A	03/02/94
US	4983188	A	08/01/91	DE	3911752	C	21/06/90
				EP	0392577	A	17/10/90
US	5707198	A	13/01/98	DE	69319916	D,T	04/03/99
				EP	0663855	A,B	26/07/95
				ES	2121096	T	16/11/98
				FI	951641	A	06/04/95
				JP	8501980	T	05/03/96
				SE	500098	C	18/04/94
				SE	9202928	A	08/04/94
				WO	9407596	A	14/04/94
				SE	9300767	D	00/00/00
US	4877423	A	31/10/89	AT	68579	T	15/11/91
				CA	1305310	A	21/07/92
				DE	3736521	C	16/02/89
				DE	3865626	A	21/11/91
				DK	165020	B,C	28/09/92
				DK	596088	A	29/04/89
				EP	0313758	A,B	03/05/89
				SE	0313758	T3	
				ES	2026614	T	01/05/92
				GR	3003014	T	17/02/93
				JP	1142314	A	05/06/89
				JP	2627938	B	09/07/97

REC'D 10 OCT 2001

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P3015	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/FI00/00546	International filing date (day/month/year) 19/06/2000	Priority date (day/month/year) 28/06/1999
International Patent Classification (IPC) or national classification and IPC B01J3/02		
Applicant FOSTER WHEELER ENERGIA OY et al.		



1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 5 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 8 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand 24/01/2001	Date of completion of this report 05.10.2001
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Nazario, L Telephone No. +49 89 2399 8137 

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/FI00/00546

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*):

Description, pages:

1,2,4-20	as originally filed	
2a,3	with telefax of	13/07/2001

Claims, No.:

1-25	with telefax of	13/07/2001
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Drawings, sheets:

1/3-3/3	as originally filed
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2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/FI00/00546

- ☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-14, 17, 19-23
	No:	Claims	15, 16, 18, 24, 25
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-25
Industrial applicability (IA)	Yes:	Claims	1-25
	No:	Claims	

- 2. Citations and explanations**
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/FI00/00546

Re Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Reference is made to the following documents:

D1: EP-A-0582049

D2: US-A-5707198

D3: JP-A-07-042910

D4: US-A-4877423 (also cited by the applicant in the description)

2. D1-D2 disclose methods and apparatuses in which particulate material is conveyed from a higher pressure vessel to another vessel through a conveyor line (equipped with cooling means). In the latter vessel the pressure is reduced and the material can subsequently be transferred and/or stored. (D1: abstract, col. 1, lines 1-5, col. 1, line 53 to col. 2, line 3, col. 2, line 50 to col. 3, line 6 and col. 4, line 5 to col. 5, line 2, claims, figure 1; D2, abstract, col. 1, lines 6-10 and 29-38, col. 3, line 36 to col. 4, line 32, claims, figure 1).

The methods disclosed in D3 and D4 comprise conveying particulate material from the reactor through a cooled conveyor to an intermediate vessel, reducing the pressure of the material and then transferring the material to a further vessel at essentially the same pressure, ca. atmospheric pressure, (D3, abstract, figure; D4: abstract, col. 1, lines 29-33, col. 1, line 62 to col. 2, line 17, col. 2, line 52 to col. 3, line 14, figure 1). D3 clearly discloses that the gas exit in the collecting vessel is controlled so that the material can be conveyed from the supply vessel to the collecting vessel (lines 1-5 of the second paragraph).

3. Therefore, D1 and D2 anticipate the subject-matter of independent claim 15 (apparatus) as well as the subject-matter of claims 16, 18, 24 and 25 so that the requirements of article 33(2) PCT are not fulfilled.

The additional features of claims 17 and 19-23 are not disclosed in the cited documents, therefore the subject-matter of these claims is novel (article 33(2) PCT). However, these additional features would be obvious design possibilities for the

**INTERNATIONAL PRELIMINARY
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skilled man in the art and cannot be considered as involving an inventive step (Article 33(3) PCT).

4. The method of claim 1 differs from the one disclosed in D3 in that reduction in pressure of the material is carried out in the collecting vessel and is therefore novel (Article 33(2) PCT).

However, such a distinguishing feature is merely one of the possibilities from which the skilled man in the art would select, in accordance to the circumstances, without the exercise of inventive skill. D3 achieves all the technical effects of the presently claimed method, i.e. It also allows the storage of particulate material at atmospheric pressure without either clogging of the conveying line or mechanical flow rate devices.

Therefore, the subject-matter of claims 1-14 does not involve an inventive step and does not fulfill the requirements of article 33(3) PCT.

Re Item VIII

Certain observations on the international application

1. To fulfill the requirements of article 6 PCT the following have to be addressed:
 - 1.1. Although claims 7, 8, 9 and relate to a method, they only include technical features of the apparatus and are therefore unclear.
 - 1.2. It seems that some of the dependent claims are not supported by the description or are only disclosed in combination with particular embodiments, i.e. their scope is broader than justified by the description (for example, page 4, lines 22-31 and claim 2).
 - 1.3. The description has not been adapted to the description.

The disclosed arrangement with a separate precipitator and two tanks is, however, quite complicated and expensive. Furthermore, the ash discharge of the separator treating the
5 entire ash quantity and having no longer any carrier gas flow, has a tendency to get clogged up, if the ash is adhesive at least to some extent. This prevents the ash from being efficiently cooled at the first stage.

10 It is an object of the present invention to provide a method and apparatus for treating particulate material, in which the above-mentioned prior art problems are minimized.

15 It is a special object of the present invention to provide a simple method and apparatus for controlled pneumatic conveyance and cooling of hot high pressure particulate material.

20 It is a further object of the invention to provide a method and apparatus for pneumatic conveyance of hot high pressure particulate material, in which no overheating and clogging of the conveyor line occur.

25 It is also an object of the invention to provide a method and an apparatus, by which the conveying speed of ash can be controlled and the consumption of carrier gas diminished.

30 In order to solve the above problems a method, the characterizing features of which are disclosed in the characterizing part of the independent method claim, is provided. Thus the method according to the present invention is characterized in that the receiving vessel comprises a discharge conduit for carrier gas and means to control the

Claims

1. Method of pneumatic conveying of particulate material containing reaction products of a high pressure reactor by using the gas exiting the reactor as a carrier gas, from a supply vessel at a pressure of at least 2 bar to a receiving vessel at a considerably lower pressure, by using an apparatus comprising a conveyor line attached to the supply vessel and a collecting vessel between the conveyor line and the receiving vessel, characterized in that the collecting vessel comprises a discharge conduit for carrier gas and means to control the flow rate of the carrier gas, said method comprising the steps of:
- (a) controlling the pressure in the collecting vessel by using the means to control the flow rate of carrier gas so that material is conveyed from the supply vessel to the collecting vessel essentially at the same pressure as is prevailing in the supply vessel, and
- (b) conveying material from the collecting vessel to the receiving vessel essentially at the same pressure as is prevailing in the receiving vessel.
2. Method of conveying particulate material according to claim 1, characterized in that step (a) is practiced by conveying particulate material as a dense suspension the flow rate of the carrier gas in the conveyor line being less than 5 m/s and the pressure drop 0.1 - 1.0 bar.
3. Method of conveying particulate material according to claim 1, characterized in that the temperature of the particulate material in the supply vessel is 400 - 1200 °C and the conveyor line is provided with heat exchange surfaces, by which the temperature of the particulate material in step (a) is reduced to less than 300 °C.

3/1

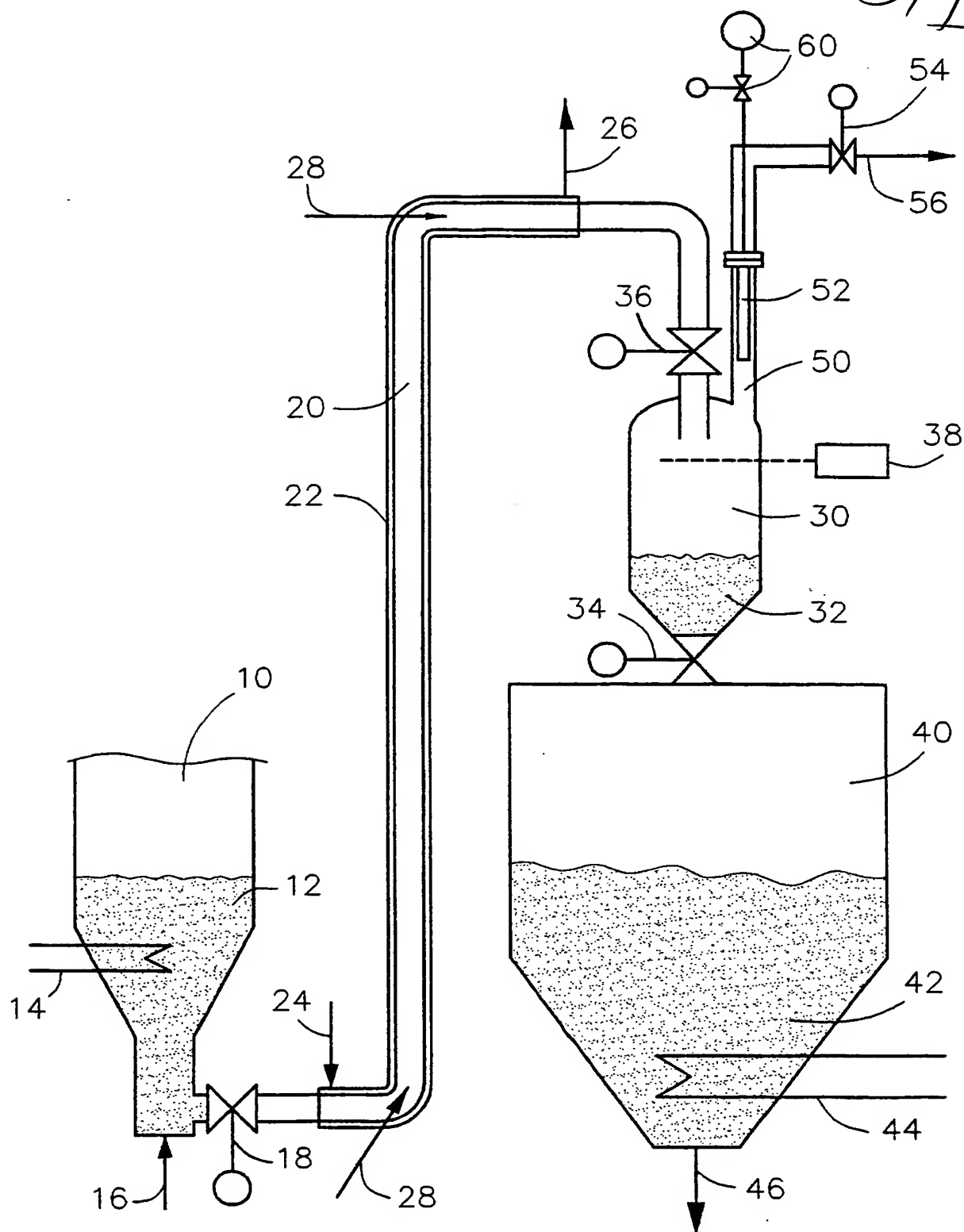


Fig 1.

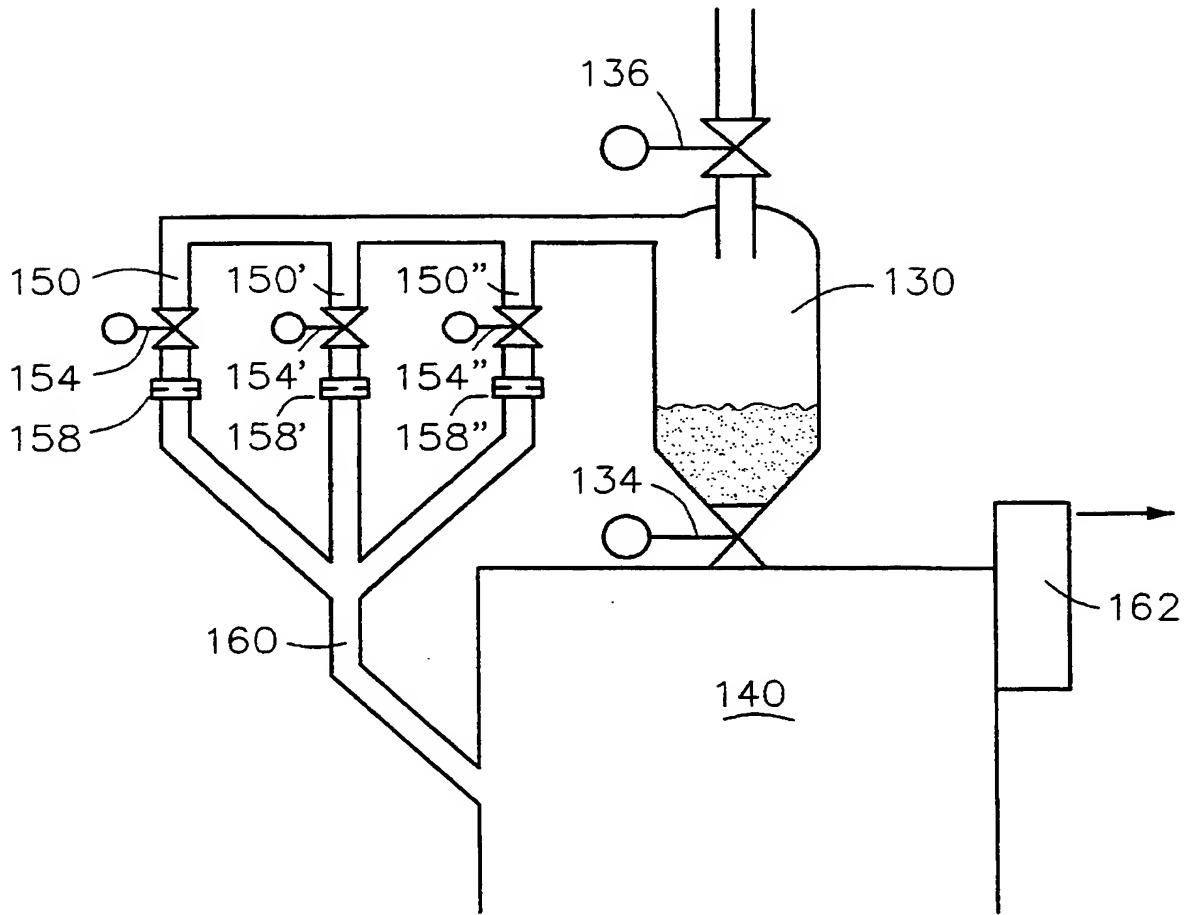


Fig.2

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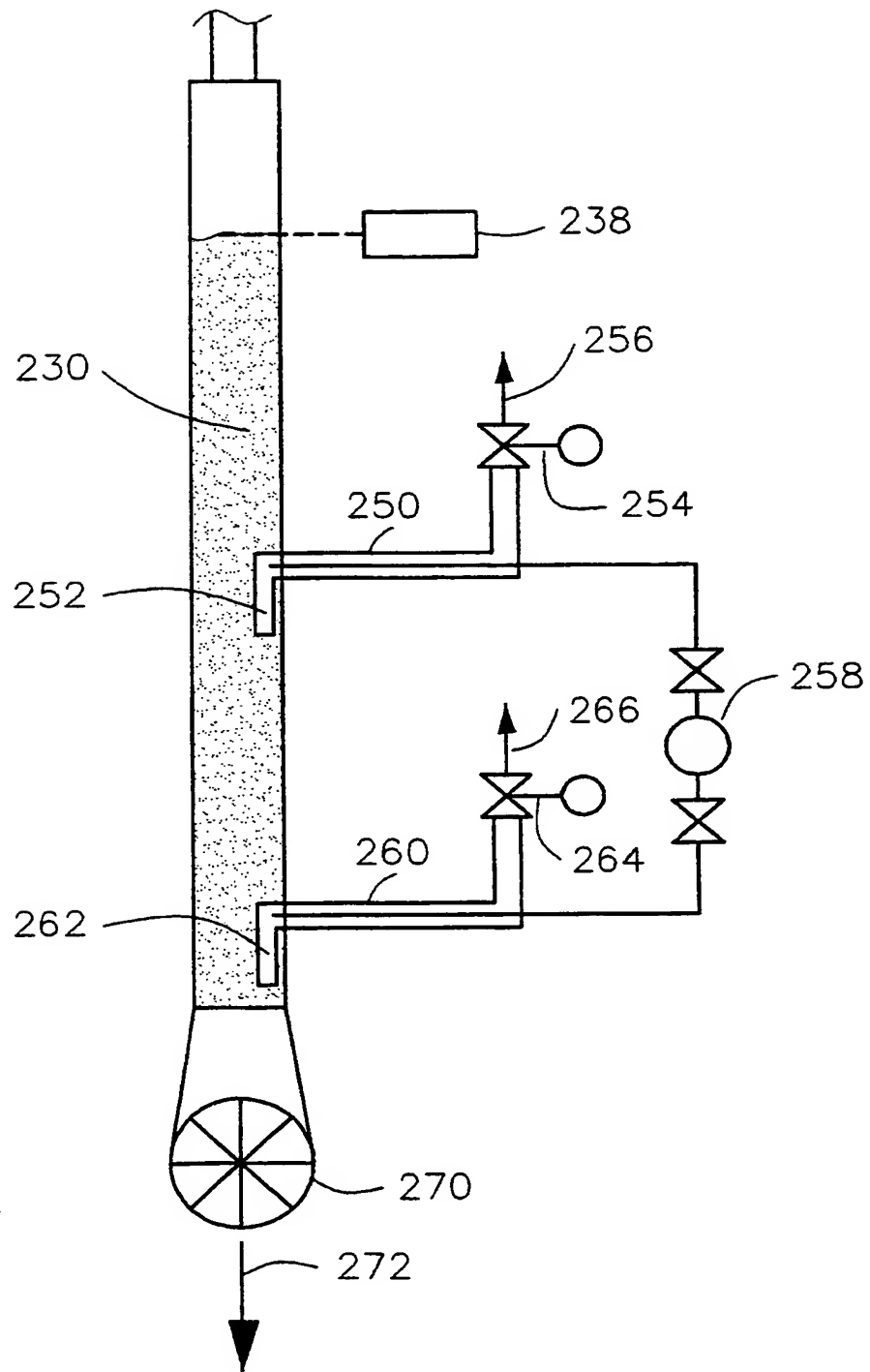


Fig.3

Claims

1. Method of conveying particulate material containing reaction products of a high pressure reactor, from a supply vessel at a pressure of at least 2 bar to a receiving vessel at a considerably lower pressure, by using an apparatus comprising a conveyor line attached to the supply vessel and a collecting vessel between the conveyor line and the receiving vessel, where said collecting vessel comprises a discharge conduit for carrier gas and means to control the discharge rate of the carrier gas, said method comprising the step of

(a) conveying particulate material from the supply vessel to the collecting vessel pneumatically by using the gas exiting the reactor as a carrier gas, and controlling the discharge rate of the carrier gas to control the pressure in the collecting vessel and the flow rate of the particulate material in the conveyor line,

characterized in that in step (a) material is conveyed from the supply vessel to the collecting vessel essentially at the same pressure as is prevailing in the supply vessel, and that the method comprises the further steps of

(b) reducing pressure of the material collected in the collecting vessel, and

(c) conveying material from the collecting vessel directly to the receiving vessel essentially at the same pressure as is prevailing in the receiving vessel.

2. Method of conveying particulate material according to claim 1, characterized in that step (a) is practiced by conveying particulate material as a dense suspension the flow rate of the carrier gas in the conveyor line being less than 5 m/s and the pressure drop 0.1 - 1.0 bar.

3. Method of conveying particulate material according to claim 1, characterized in that the temperature of the particulate material in the supply vessel is 400 - 1200 °C and the conveyor line is provided with heat exchange surfaces, by which the temperature of the particulate material in step (a) is reduced to less than 300 °C.

4. Method of conveying particulate material according to claim 3, characterized in that the particulate material in the supply vessel is fluidized by air that is mixed in the carrier gas decreasing the dew point thereof.

5. Method of conveying particulate material according to claim 1, characterized in that a filter is arranged in the discharge conduit for carrier gas, the means to control the flow rate of the gas includes a control valve downstream from the filter, and in step (a) the carrier gas is discharged from the collecting vessel to a space at the pressure which is essentially the same as is prevailing in the receiving vessel.

6. Method of conveying particulate material according to claim 1, characterized in that the carrier gas is discharged from the collecting vessel to the receiving vessel in step (a).

7. Method of conveying particulate material according to claim 6, characterized in that more than one parallel lines for the discharge of carrier gas are provided between the collecting vessel and the receiving vessel, which lines are provided with a constantly open flow restricting element and a shut-off valve, and the control of the discharge velocity is performed by opening and shutting the shut-off valves.

8. Method of conveying particulate material according to claim 7, characterized in that the flow restricting elements are easily changeable.

5 9. Method of conveying particulate material according to claim 5, characterized in that the collecting vessel has an elongated form and it is arranged in a vertical position, and a column of particulate material is maintained in the collecting vessel, and the discharge conduit for carrier gas
10 is attached to the collecting vessel at the bottom section of the particulate material column.

10. Method of conveying particulate material according to claim 9, characterized in that more than one discharge conduit
15 for carrier gas are provided and these are attached to the collecting vessel at various levels of the particulate material column.

11. Method of conveying particulate material according to claim 9, characterized in that the pressure in the bottom
20 section of the particulate material column is approximately the same as is prevailing in the receiving vessel and step (c) is practiced intermittently or continuously from the bottom section of the collecting vessel.

25 12. Method of conveying particulate material according to claim 1, characterized in that a gas tight inlet valve is disposed in the conveyor line before the collecting vessel and a gas tight discharge valve is disposed between the collecting
30 vessel and the receiving vessel, and steps (a) - (c) are practiced in alteration steps (b) and (c) comprising the sub-steps of:

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(b1) stopping the discharge of carrier gas from the collecting vessel by using the means to control the carrier gas flow, whereby the conveyance of particulate material is stopped;

(b2) closing the shut-off valve before the collecting vessel;

5 (b3) allowing the discharge of carrier gas from the collecting vessel until the pressure in the collecting vessel has dropped approximately to the same level as the pressure of the receiving vessel;

10 (c1) opening the discharge valve and conveying the particulate material from the collecting vessel to the receiving vessel; and

(c2) closing the discharge valve, opening the inlet valve and returning to step (a).

15 13. Method of conveying particulate material according to claim 1, characterized in that the collecting vessel is disposed above the receiving vessel and in step (c) the particulate material is allowed to fall down to the receiving vessel.

20 14. Method of conveying particulate material according to claim 1, characterized in that in step (a) the flow rate of the carrier gas is periodically changed by stopping the conveyance for a predetermined time at regular intervals or
25 when the pressure in the collecting vessel or the temperature of the material entering the collecting vessel is not within predetermined limits.

30 15. Apparatus for pneumatic conveying of particulate material containing reaction products of a high pressure reactor from a supply vessel at a pressure of at least 2 bar to a receiving vessel at a considerably lower pressure, said apparatus comprising a conveyor line attached to the supply vessel and a collecting vessel between the conveyor line and the receiving

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vessel, where said collecting vessel comprises a discharge conduit for carrier gas and means to control the discharge velocity of the carrier gas from the collecting vessel, characterized in that the collecting vessel comprises means to control the pressure of the material collected in the collecting vessel, and said apparatus comprises means for conveying the material directly from the collecting vessel to the receiving vessel essentially at the same pressure as is prevailing in the receiving vessel.

16. Apparatus for conveying particulate material according to claim 15, characterized in that heat exchange surfaces are disposed in the conveyor line.

17. Apparatus for conveying particulate material according to claim 16, characterized in that elements for fluidizing the particulate material are disposed in the supply vessel in such a way that air used for the fluidization is mixed in the carrier gas thus decreasing the dew point of the carrier gas.

18. Apparatus for conveying particulate material according to claim 15, characterized in that a filter is disposed in the discharge conduit for carrier gas, the means to control the flow rate of the carrier gas including a control valve is arranged downstream from the filter, and the discharge conduit for carrier gas is in flow communication with the open air.

19. Apparatus for conveying particulate material according to claim 15, characterized in that the discharge conduit for carrier gas is in flow communication with the receiving vessel.

20. Apparatus for conveying particulate material according to claim 19, characterized in that more than one parallel lines

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for the discharge of carrier gas are provided between the collecting vessel and the receiving vessel, which lines are provided with a constantly open flow restricting element and a shut-off valve.

5

21. Apparatus for conveying particulate material according to claim 20, characterized in that the flow restricting elements are easily changeable.

10

22. Apparatus for conveying particulate material according to claim 15, characterized in that the collecting vessel has an elongated form and it is disposed in a vertical position, and the discharge conduit for carrier gas is attached to bottom section of the collecting vessel.

15

23. Apparatus for conveying particulate material according to claim 22, characterized in that more than one discharge conduit for carrier gas are provided and these are attached to the collecting vessel at various levels.

20

24. Apparatus for conveying particulate material according to claim 15, characterized in that a gas tight valve is disposed in the conveyor line before the collecting vessel and between the collecting vessel and the receiving vessel.

25

25. Apparatus for conveying particulate material according to claim 15, characterized in that the collecting vessel is disposed above the receiving vessel and a valve is arranged between the vessels, through which valve the particulate material may fall down to the receiving vessel.

30

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2a

The disclosed arrangement with a separate precipitator and two tanks is, however, quite complicated and expensive. Furthermore, the ash discharge of the separator treating the entire ash quantity and having no longer any carrier gas flow, has a tendency to get clogged up, if the ash is adhesive at least to some extent. This prevents the ash from being efficiently cooled at the first stage.

10 European patent 0 582 049 discloses a system for depressurizing and conveying particulate materials, where the solids flow rate in the pneumatic conveyor line is controlled by changing the cross section of a choke means and/or by changing the pressure in a reservoir upstream the conveyor
15 line. The material is also depressurized by the mechanical choke means.

US patent 5,707,198 discloses a system for discharging particulate material from a first container to a lower positioned, lower pressure storage area. The quantity of material discharged to the storage area is controlled by a material feeder. The pressure of the material is reduced in the material columns formed in an upper tube section between the first container and a pressure stabilizer and a lower
20 tube section between the pressure stabilizer and the feeder.

Japanese patent publication JP 07042910 discloses a system for pneumatic conveying of particulate material, where the material is first conveyed to a high pressure ash storing device, from where it is transferred to a separate hopper in order to reduce the pressure to the atmospheric pressure, and then the material is finally transferred to a normal pressure hopper.
30

~~The disclosed arrangement with a separate precipitator and two tanks is, however, quite complicated and expensive. Furthermore, the ash discharge of the separator treating the entire ash quantity and having no longer any carrier gas flow, has a tendency to get clogged up, if the ash is adhesive at least to some extent. This prevents the ash from being efficiently cooled at the first stage.~~

10 It is an object of the present invention to provide a method and apparatus for treating particulate material, in which the above-mentioned prior art problems are minimized.

15 It is a special object of the present invention to provide a simple method and apparatus for controlled pneumatic conveyance and cooling of hot high pressure particulate material.

20 It is a further object of the invention to provide a method and apparatus for pneumatic conveyance of hot high pressure particulate material, in which no overheating and clogging of the conveyor line occur.

25 It is also an object of the invention to provide a method and an apparatus, by which the conveying speed of ash can be controlled and the consumption of carrier gas diminished.

30 In order to solve the above problems a method, the characterizing features of which are disclosed in the characterizing part of the independent method claim, is provided. Thus the method according to the present invention is characterized in that the receiving vessel comprises a discharge conduit for carrier gas and means to control the

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add B2

Claims

added A1

1. Method of conveying particulate material containing reaction products of a high pressure reactor, from a supply vessel at a pressure of at least 2 bar to a receiving vessel at a considerably lower pressure, by using an apparatus comprising a conveyor line attached to the supply vessel and a collecting vessel between the conveyor line and the receiving vessel, where said collecting vessel comprises a discharge conduit for carrier gas and means to control the discharge rate of the carrier gas, said method comprising the step of
- (a) conveying particulate material from the supply vessel to the collecting vessel pneumatically by using the gas exiting the reactor as a carrier gas, and controlling the discharge rate of the carrier gas to control the flow rate of the particulate material in the conveyor line, characterized in that in step (a) the pressure in the collecting vessel is controlled by using said means to control the discharge rate of the carrier gas so that material is conveyed from the supply vessel to the collecting vessel essentially at the same pressure as is prevailing in the supply vessel, and that the method comprises the further steps of
- (b) reducing pressure of the material collected in the collecting vessel, and
- (c) conveying material from the collecting vessel directly to the receiving vessel essentially at the same pressure as is prevailing in the receiving vessel.
2. Method of conveying particulate material according to claim 1, characterized in that step (a) is practiced by conveying particulate material as a dense suspension the flow rate of the carrier gas in the conveyor line being less than 5 m/s and the pressure drop 0.1 - 1.0 bar.

3. Method of conveying particulate material according to claim 1, characterized in that the temperature of the particulate material in the supply vessel is 400 - 1200 °C and the conveyor line is provided with heat exchange surfaces, by which the temperature of the particulate material in step (a) is reduced to less than 300 °C.

4. Method of conveying particulate material according to claim 3, characterized in that the particulate material in the supply vessel is fluidized by air that is mixed in the carrier gas decreasing the dew point thereof.

5. Method of conveying particulate material according to claim 1, characterized in that a filter is arranged in the discharge conduit for carrier gas, the means to control the flow rate of the gas includes a control valve downstream from the filter, and in step (a) the carrier gas is discharged from the collecting vessel to a space at the pressure which is essentially the same as is prevailing in the receiving vessel.

6. Method of conveying particulate material according to claim 1, characterized in that the carrier gas is discharged from the collecting vessel to the receiving vessel in step (a).

7. Method of conveying particulate material according to claim 6, characterized in that more than one parallel lines for the discharge of carrier gas are provided between the collecting vessel and the receiving vessel, which lines are provided with a constantly open flow restricting element and a shut-off valve, and the control of the discharge velocity is performed by opening and shutting the shut-off valves.

8. Method of conveying particulate material according to claim 7, characterized in that the flow restricting elements are easily changeable.

9. Method of conveying particulate material according to claim 5, characterized in that the collecting vessel has an elongated form and it is arranged in a vertical position, and a column of particulate material is maintained in the collecting vessel, and the discharge conduit for carrier gas is attached to the collecting vessel at the bottom section of the particulate material column.

10. Method of conveying particulate material according to claim 9, characterized in that more than one discharge conduit for carrier gas are provided and these are attached to the collecting vessel at various levels of the particulate material column.

11. Method of conveying particulate material according to claim 9, characterized in that the pressure in the bottom section of the particulate material column is approximately the same as is prevailing in the receiving vessel and step (c) is practiced intermittently or continuously from the bottom section of the collecting vessel.

12. Method of conveying particulate material according to claim 1, characterized in that a gas tight inlet valve is disposed in the conveyor line before the collecting vessel and a gas tight discharge valve is disposed between the collecting vessel and the receiving vessel, and steps (a) - (c) are practiced in alteration steps (b) and (c) comprising the sub-steps of:

(b1) stopping the discharge of carrier gas from the collecting vessel by using the means to control the carrier gas flow, whereby the conveyance of particulate material is stopped;

(b2) closing the shut-off valve before the collecting vessel;

5 (b3) allowing the discharge of carrier gas from the collecting vessel until the pressure in the collecting vessel has dropped approximately to the same level as the pressure of the receiving vessel;

(c1) opening the discharge valve and conveying the particulate material from the collecting vessel to the receiving vessel; and

(c2) closing the discharge valve, opening the inlet valve and returning to step (a).

15 13. Method of conveying particulate material according to claim 1, characterized in that the collecting vessel is disposed above the receiving vessel and in step (c) the particulate material is allowed to fall down to the receiving vessel.

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14. Method of conveying particulate material according to claim 1, characterized in that in step (a) the flow rate of the carrier gas is periodically changed by stopping the conveyance for a predetermined time at regular intervals or

25 when the pressure in the collecting vessel or the temperature of the material entering the collecting vessel is not within predetermined limits.

15. Apparatus for pneumatic conveying of particulate material containing reaction products of a high pressure reactor from a supply vessel at a pressure of at least 2 bar to a receiving vessel at a considerably lower pressure, said apparatus comprising a conveyor line attached to the supply vessel and a collecting vessel between the conveyor line and the receiving

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vessel, where said collecting vessel comprises a discharge conduit for carrier gas and means to control the discharge velocity of the carrier gas from the collecting vessel, characterized in that the collecting vessel comprises means to control the pressure of the material collected in the collecting vessel, and said apparatus comprises means for conveying the material directly from the collecting vessel to the receiving vessel essentially at the same pressure as is prevailing in the receiving vessel.

16. Apparatus for conveying particulate material according to claim 15, characterized in that heat exchange surfaces are disposed in the conveyor line.

17. Apparatus for conveying particulate material according to claim 16, characterized in that elements for fluidizing the particulate material are disposed in the supply vessel in such a way that air used for the fluidization is mixed in the carrier gas thus decreasing the dew point of the carrier gas.

18. Apparatus for conveying particulate material according to claim 15, characterized in that a filter is disposed in the discharge conduit for carrier gas, the means to control the flow rate of the carrier gas including a control valve is arranged downstream from the filter, and the discharge conduit for carrier gas is in flow communication with the open air.

19. Apparatus for conveying particulate material according to claim 15, characterized in that the discharge conduit for carrier gas is in flow communication with the receiving vessel.

20. Apparatus for conveying particulate material according to claim 19, characterized in that more than one parallel lines

for the discharge of carrier gas are provided between the collecting vessel and the receiving vessel, which lines are provided with a constantly open flow restricting element and a shut-off valve.

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21. Apparatus for conveying particulate material according to claim 20, characterized in that the flow restricting elements are easily changeable.

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22. Apparatus for conveying particulate material according to claim 15, characterized in that the collecting vessel has an elongated form and it is disposed in a vertical position, and the discharge conduit for carrier gas is attached to bottom section of the collecting vessel.

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23. Apparatus for conveying particulate material according to claim 22, characterized in that more than one discharge conduit for carrier gas are provided and these are attached to the collecting vessel at various levels.

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24. Apparatus for conveying particulate material according to claim 15, characterized in that a gas tight valve is disposed in the conveyor line before the collecting vessel and between the collecting vessel and the receiving vessel.

25

25. Apparatus for conveying particulate material according to claim 15, characterized in that the collecting vessel is disposed above the receiving vessel and a valve is arranged between the vessels, through which valve the particulate material may fall down to the receiving vessel.

30

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

FOSTER WHEELER ENERGIA OY
Patent Department
Antintie 3
P.O. Box 66
FIN-48601 Karhula
FINLANDE

RECEIVED

12.10.2001

FOSTER WHEELER ENERGIA OY
Patent Department

PO

NOTIFICATION OF TRANSMITTAL OF
THE INTERNATIONAL PRELIMINARY
EXAMINATION REPORT

(PCT Rule 71.1)

Date of mailing
(day/month/year) 05.10.2001

Applicant's or agent's file reference

P3015

Cuikson et al

IMPORTANT NOTIFICATION

International application No.

PCT/FI00/00546

International filing date (day/month/year)

19/06/2000

Priority date (day/month/year)

28/06/1999

Applicant

FOSTER WHEELER ENERGIA OY et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. REMINDER

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/



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D-80298 Munich
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Authorized officer

Ferro Vasconcelos, M

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8061





PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P3015	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/FI00/00546	International filing date (day/month/year) 19/06/2000	Priority date (day/month/year) 28/06/1999
International Patent Classification (IPC) or national classification and IPC B01J3/02		
Applicant FOSTER WHEELER ENERGIA OY et al.		
<p>1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 5 sheets, including this cover sheet.</p> <p><input checked="" type="checkbox"/> This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).</p> <p>These annexes consist of a total of 8 sheets.</p>		
<p>3. This report contains indications relating to the following items:</p> <ul style="list-style-type: none">I <input checked="" type="checkbox"/> Basis of the reportII <input type="checkbox"/> PriorityIII <input type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicabilityIV <input type="checkbox"/> Lack of unity of inventionV <input checked="" type="checkbox"/> Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statementVI <input type="checkbox"/> Certain documents citedVII <input type="checkbox"/> Certain defects in the international applicationVIII <input checked="" type="checkbox"/> Certain observations on the international application		
Date of submission of the demand 24/01/2001	Date of completion of this report 05.10.2001	
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Nazario, L Telephone No. +49 89 2399 8137 	

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/FI00/00546

I. Basis of the report

1. With regard to the elements of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, pages:

1,2,4-20	as originally filed	
2a,3	with telefax of	13/07/2001

Claims, No.:

1-25	with telefax of	13/07/2001
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Drawings, sheets:

1/3-3/3	as originally filed
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2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/FI00/00546

- ☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-14, 17, 19-23
	No:	Claims	15, 16, 18, 24, 25
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-25
Industrial applicability (IA)	Yes:	Claims	1-25
	No:	Claims	

- 2. Citations and explanations**
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

Re Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Reference is made to the following documents:

D1: EP-A-0582049

D2: US-A-5707198

D3: JP-A-07-042910

D4: US-A-4877423 (also cited by the applicant in the description)

2. D1-D2 disclose methods and apparatuses in which particulate material is conveyed from a higher pressure vessel to another vessel through a conveyor line (equipped with cooling means). In the latter vessel the pressure is reduced and the material can subsequently be transferred and/or stored. (D1: abstract, col. 1, lines 1-5, col. 1, line 53 to col. 2, line 3, col. 2, line 50 to col. 3, line 6 and col. 4, line 5 to col. 5, line 2, claims, figure 1; D2, abstract, col. 1, lines 6-10 and 29-38, col. 3, line 36 to col. 4, line 32, claims, figure 1).

The methods disclosed in D3 and D4 comprise conveying particulate material from the reactor through a cooled conveyor to an intermediate vessel, reducing the pressure of the material and then transferring the material to a further vessel at essentially the same pressure, ca. atmospheric pressure, (D3, abstract, figure; D4: abstract, col. 1, lines 29-33, col. 1, line 62 to col. 2, line 17, col. 2, line 52 to col. 3, line 14, figure 1). D3 clearly discloses that the gas exit in the collecting vessel is controlled so that the material can be conveyed from the supply vessel to the collecting vessel (lines 1-5 of the second paragraph).

3. Therefore, D1 and D2 anticipate the subject-matter of independent claim 15 (apparatus) as well as the subject-matter of claims 16, 18, 24 and 25 so that the requirements of article 33(2) PCT are not fulfilled.

The additional features of claims 17 and 19-23 are not disclosed in the cited documents, therefore the subject-matter of these claims is novel (article 33(2) PCT). However, these additional features would be obvious design possibilities for the

skilled man in the art and cannot be considered as involving an inventive step (Article 33(3) PCT).

4. The method of claim 1 differs from the one disclosed in D3 in that reduction in pressure of the material is carried out in the collecting vessel and is therefore novel (Article 33(2) PCT).

However, such a distinguishing feature is merely one of the possibilities from which the skilled man in the art would select, in accordance to the circumstances, without the exercise of inventive skill. D3 achieves all the technical effects of the presently claimed method, i.e. It also allows the storage of particulate material at atmospheric pressure without either clogging of the conveying line or mechanical flow rate devices.

Therefore, the subject-matter of claims 1-14 does not involve an inventive step and does not fulfill the requirements of article 33(3) PCT.

Re Item VIII

Certain observations on the international application

1. To fulfill the requirements of article 6 PCT the following have to be addressed:
 - 1.1. Although claims 7, 8, 9 and relate to a method, they only include technical features of the apparatus and are therefore unclear.
 - 1.2. It seems that some of the dependent claims are not supported by the description or are only disclosed in combination with particular embodiments, i.e. their scope is broader than justified by the description (for example, page 4, lines 22-31 and claim 2).
 - 1.3. The description has not been adapted to the description.

From the:
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

FOSTER WHEELER ENERGIA OY
Patent Department
Antintie 3
P.O. Box 66
FIN-48601 Karhula
FINLANDE

RECEIVED

23.04.2001

FOSTER WHEELER ENERGIA OY
Patent Department

PCT

WRITTEN OPINION

(PCT Rule 66)

Date of mailing
(day/month/year) 19.04.2001

Applicant's or agent's file reference
P3015 *Eriksson et al*

REPLY DUE within 3 month(s)
from the above date of mailing 19.7.01

International application No.
PCT/FI00/00546

International filing date (day/month/year)
19/06/2000

Priority date (day/month/year)
28/06/1999

International Patent Classification (IPC) or both national classification and IPC
B01J3/02

Applicant

FOSTER WHEELER ENERGIA OY et al.

1. This written opinion is the first drawn up by this International Preliminary Examining Authority.
2. This opinion contains indications relating to the following items:
 - I ☒ Basis of the opinion
 - II ☐ Priority
 - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
 - IV ☐ Lack of unity of invention
 - V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
 - VI ☐ Certain document cited
 - VII ☒ Certain defects in the international application
 - VIII ☒ Certain observations on the international application
3. The applicant is hereby invited to reply to this opinion.

When? See the time limit indicated above. The applicant may, before the expiration of that time limit, request this Authority to grant an extension, see Rule 66.2(d).

How? By submitting a written reply, accompanied, where appropriate, by amendments, according to Rule 66.3. For the form and the language of the amendments, see Rules 66.8 and 66.9.

Also: For an additional opportunity to submit amendments, see Rule 66.4.
For the examiner's obligation to consider amendments and/or arguments, see Rule 66.4 bis.
For an informal communication with the examiner, see Rule 66.6.

If no reply is filed, the international preliminary examination report will be established on the basis of this opinion.
4. The final date by which the international preliminary examination report must be established according to Rule 69.2 is: 28/10/2001.

Name and mailing address of the international preliminary examining authority:



European Patent Office
D-80298 Munich
Tel. +49 89 2399 - 0 Tx: 523656 epmu d
Fax: +49 89 2399 - 4465

Authorized officer / Examiner

Nazario, L

Formalities officer (incl. extension of time limits)
Gregoire, J-P
Telephone No. +49 89 2399 8041



I. Basis of the opinion

1. With regard to the elements of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this opinion as "originally filed"*):

Description, pages:

1-20 as originally filed

Claims, No.:

1-25 with telefax of 24/01/2001

Drawings, sheets:

1/3-3/3 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

Re Item V

Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. New claim 1 no longer includes the feature "... the collecting vessel comprising a discharge conduit for carrier gas ...", the application as originally filed does not seem to include a method for conveying particulate material that does not include using an apparatus comprising such a feature. Therefore, the amendment does not fulfill the requirements of article 19(2) PCT and the present opinion has been established without taking it into account. ok

2. Reference is made to the following documents:

D1: EP-A-0582049

D2: US-A-5707198

D3: JP-A-07-042910

D4: US-A-4877423 (also cited by the applicant in the description)

D5: US-A-4983188

3. D1-D3 disclose methods (and apparatuses) in which particulate material is conveyed from a higher pressure vessel to another vessel through a conveyor line (equipped with cooling means). In the latter vessel the pressure is reduced and the material can subsequently be transferred and/or stored. (D1: abstract, col. 1, lines 1-5, col. 1, line 53 to col. 2, line 3, col. 2, line 50 to col. 3, line 6 and col. 4, line 5 to col. 5, line 2, claims, figure 1; D2, abstract, col. 1, lines 6-10 and 29-38, col. 3, line 36 to col. 4, line 32, claims, figure 1; D3, abstract, figure). y

The method disclosed in D4 also includes conveying particulate material from the reactor through a cooled conveyor to an intermediate vessel, reducing the pressure of the material and then transferring the material to a further vessel at essentially the same pressure (ca. atmospheric pressure). (abstract, col. 1, lines 29-33, col. 1, line 62 to col. 2, line 17, col. 2, line 52 to col. 3, line 14, figure 1).

Therefore, D1-D4 anticipate the subject-matter of independent claims 1 (method) and 15 (apparatus) as well as the subject-matter of claims 3, 5, 6, 12-14, 16, 18, 24 and

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N) Claims 1, 3, 5, 6, 12-16, 18, 24, 25

Inventive step (IS) Claims 1-25

Industrial applicability (IA) Claims

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

25 so that the requirements of article 33(2) PCT are not fulfilled.

4. The additional features of claims 2, 4, 7-11, 17 and 19-23 are not disclosed in the cited documents, therefore the subject-matter of these claims is novel (article 33(2) PCT). However, these additional features would be obvious design possibilities for the skilled man in the art and cannot be considered as involving an inventive step.

Therefore the subject-matter of the above claims does not fulfill the requirements of article 33(3) PCT.

5. Given the disclosures of D1-D4 and that it is known in the art to use an intermediate vessel to regulate the pressure at which the particulate material is transferred (see also D5: abstract, col. 2, lines 4-35) and that the cited methods have the same technical effects (i.e. pneumatic conveyance and cooling of particulate with reduced clogging), the applicant should indicate in the letter of reply the difference of the subject-matter of any new claim vis-à-vis the state of the art and the significance thereof towards the requirement of inventive step. In this connection, the problem to be solved should be clearly stated, as well as the specific features of its solution and why the solution is deemed to be inventive.
6. The applicant's attention is drawn to the fact that the application may not be amended in such a way that it introduces subject-matter which extends beyond the content of the application as filed (Article 34(2)(b) PCT).

Any information the applicant may wish to submit concerning the subject-matter of the invention, for example further details of its advantages or of the problem it solves, and for which there is no basis in the application as filed, should be confined to the letter of reply and not be incorporated into the application. It is also requested, in order to facilitate the examination of the conformity of the amended application with the requirements of Article 34(2)(b) PCT, to clearly identify the amendments carried out, irrespective of whether they concern amendments by addition, replacement or deletion, and to indicate the passages of the application as filed on which these amendments are based.

If the applicant regards it as appropriate these indications could be submitted in

handwritten form on a copy of the relevant parts of the application as filed.

Re Item VII

Certain defects in the international application

1. Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the documents D1-D3 is not mentioned in the description, nor are these documents identified therein.

Re Item VIII

Certain observations on the international application

1. To fulfill the requirements of article 6 PCT the following have to be addressed:
 - 1.1. Although claims 7, 8, 9 and relate to a method, they only include technical features of the apparatus and are therefore unclear.
 - 1.2. It seems that some of the dependent claims are not supported by the description or are only disclosed in combination with particular embodiments (for example, page 4, lines 22-31 and claim 2).
 - 1.3. The description has not been adapted to the description.

INTERNATIONAL SEARCH REPORT

Information on patent family members

01/08/00

International application No.

PCT/FI 00/00546

Patent document cited in search report			Publication date	Patent family member(s)	Publication date
EP	0582049	A1	09/02/94	DE 4225482 A	03/02/94
US	4983188	A	08/01/91	DE 3911752 C	21/06/90
				EP 0392577 A	17/10/90
US	5707198	A	13/01/98	DE 69319916 D,T	04/03/99
				EP 0663855 A,B	26/07/95
				ES 2121096 T	16/11/98
				FI 951641 A	06/04/95
				JP 8501980 T	05/03/96
				SE 500098 C	18/04/94
				SE 9202928 A	08/04/94
				WO 9407596 A	14/04/94
				SE 9300767 D	00/00/00
US	4877423	A	31/10/89	AT 68579 T	15/11/91
				CA 1305310 A	21/07/92
				DE 3736521 C	16/02/89
				DE 3865626 A	21/11/91
				DK 165020 B,C	28/09/92
				DK 596088 A	29/04/89
				EP 0313758 A,B	03/05/89
				SE 0313758 T3	
				ES 2026614 T	01/05/92
				GR 3003014 T	17/02/93
				JP 1142314 A	05/06/89
				JP 2627938 B	09/07/97

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 00/00546

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Patent Abstracts of Japan, abstract of JP 7-42910 A (MITSUBISHI HEAVY IND LTD), 10 February 1995 (10.02.95)	15,16,24,25
A	--	1-3,13
X	US 4877423 A (FRANK DZIOBEK ET AL), 31 October 1989 (31.10.89), column 1, line 62 - column 2, line 17, figure 1	15,16,25
A	-- -----	1-3,13

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 00/00546

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B01J 3/02, F23C 10/16, F23C 10/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B01J, B65G, F23C, F23J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0582049 A1 (DEUTSCHE BABCOCK ENERGIE- UND UMWELTECHNIK AKTIENGESellschaft), 9 February 1994 (09.02.94), column 4, line 54 - column 5, line 2, figure 1 --	1,5,14,15,18
X	US 4983188 A (HORST MIELKE ET AL), 8 January 1991 (08.01.91), column 2, line 4 - line 29, figure 1 --	1,12-15,18, 22,24,25
X	US 5707198 A (TYGE VIND), 13 January 1998 (13.01.98), column 1, line 57 - column 2, line 8; column 3, line 66 - column 4, line 16, figure 1, abstract --	1,13,15,25

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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Date of the actual completion of the international search

11 October 2000

Date of mailing of the international search report

18 -10- 2000

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(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

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Arlington, VA 22202
ETATS-UNIS D'AMERIQUE**
in its capacity as elected Office

Date of mailing (day/month/year) 14 March 2001 (14.03.01)	ETATS-UNIS D'AMERIQUE in its capacity as elected Office
International application No. PCT/FI00/00546	Applicant's or agent's file reference P3015
International filing date (day/month/year) 19 June 2000 (19.06.00)	Priority date (day/month/year) 28 June 1999 (28.06.99)
Applicant ERIKSSON, Timo et al	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:

24 January 2001 (24.01.01)

☐ in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was ☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

<p>The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland</p> <p>Facsimile No.: (41-22) 740.14.35</p>	<p>Authorized officer</p> <p>Claudio Borton</p> <p>Telephone No.: (41-22) 338.83.38</p>
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